Space Weather Technical Forecast

Issued on Monday, 05 December 2022 at 12:45 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Active high energy electron fluence Day 1 (5th). Daily chance of M-flares. Chance of G1/Minor Storms Day 3 (7 Dec).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low with occasional minor C-class flares observed. There are currently five numbered and one unnumbered sunspot regions on the visible disc. Large and mature region AR3153 Fko/Beta in the southeast has shown some growth in its intermediate spots, but appears relatively stable. The main developmental regions observed were AR3158 Dai/Beta-Gamma and AR3155 Dsi/Beta, both in the north central disc. No Earth-directed CMEs were observed in available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds has observed at L1 from ACE/DSCOVR have been Elevated to Slightly Elevated, peaking near 550km/s at 05/0710UTC, before a gradual decline to around 480km/s at present. Density also remained average to slightly above average. Total IMF, Bt, was generally weak between 4-6 nT, but saw a slight increase between approximately 04/1200 and 04/1600 UTC to a peak of around 9nT. The north-south component Bz was general variable, fluctuating between -7 nT and +5 nT but also saw a more sustained period of negative values between approximately 04/1200 and 04/1600 UTC to a minimum of around -8nT, these perhaps signalling transient CME effects. Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet to Active(Kp 0-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES-16 has been High for much of the period, peaking at 9710pfu at 04/1405 UTC, before seeing a reduction back to Moderate levels. The associated 24-hour Fluence was above the Active (1e8 integrated pfu) threshold throughout with a slight declining trend. Observed fluence at 05/0000 UTC was 5.02e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity is expected to continue, with occasional C-class flares expected, and the daily chance of isolated M-class flares increasing activity to Moderate.

Solar Wind / Geomagnetic Activity: Waning effects of HSS from CH51/+ and the likely passage of a transient slow CME to start with, wind speeds are expected to decline slowly towards Background through days 1 and 2 (5th and 6th Dec). The next HSS is expected to arrive into Day 3 (7th) from CH53/-, peak winds 500-600 km/s signalled, persisting into Day 4 (8th). Geomagnetic activity is expected to be mainly Quiet to Unsettled days 1 and 2 (5th and 6th Dec), increasing to Unsettled to Active days 3 and 4 (7th and 8th Dec), with a chance of G1/Minor storm intervals into day 3 (7th Dec).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES-16, is expected to remain at Background throughout. High energy electron flux (greater than 2 MeV), as observed by GOES-16, is expected to remain

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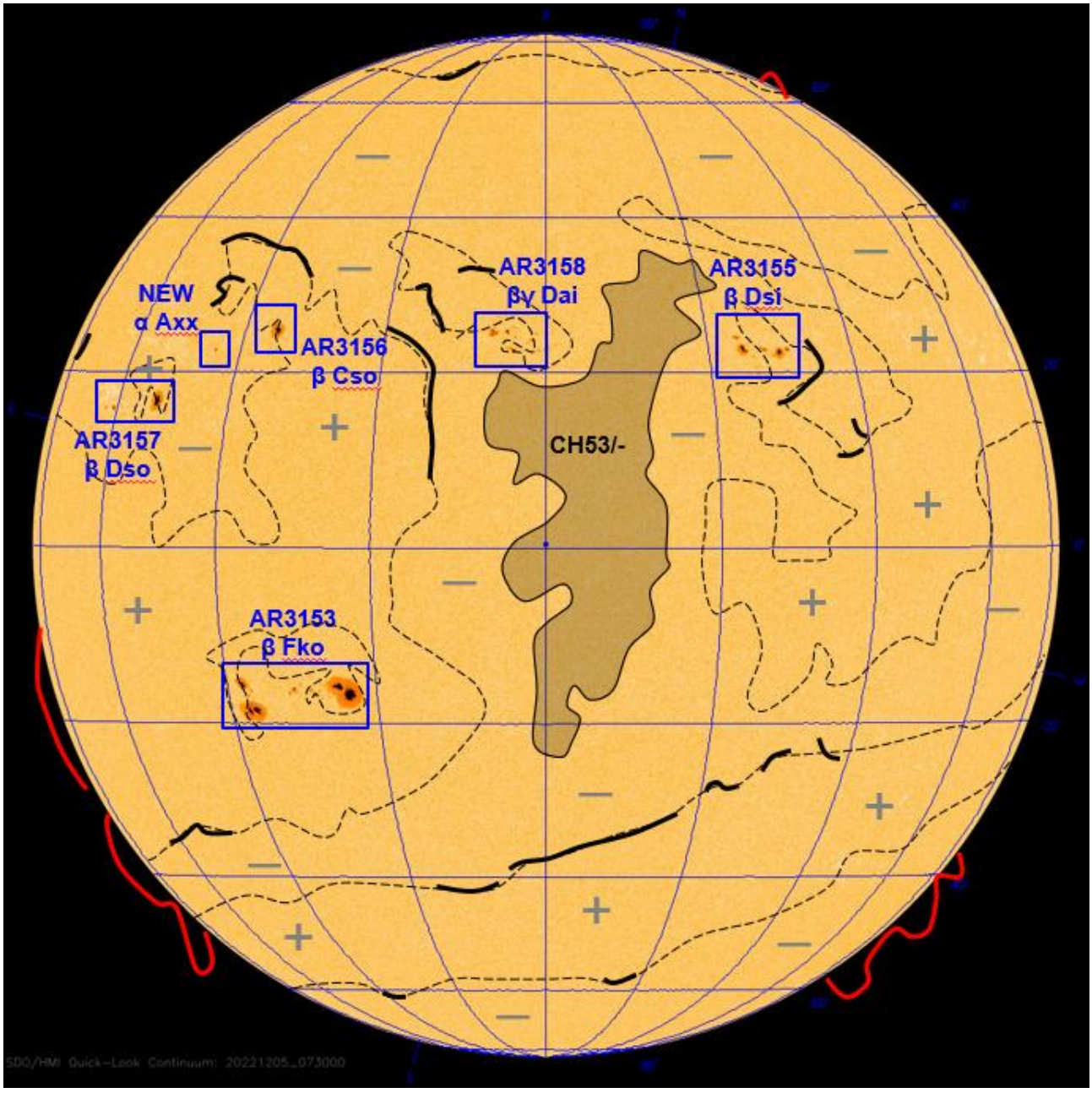
predominantly High during Day 1 (5th), with Fluence levels also persisting above the Active (1e8 integrated pfu) fluence threshold, before a gradual decline to below threshold later on Day 1 (5th) or early Day 2 (6th).

Figure 1. Solar Analysis Valid 05/0730UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME produced by a filament eruption on 29 Nov looks to have passed, giving a period of more strongly negative Bz and slightly elevated Bt through the afternoon of the 4th which now looks to have cleared. No other Earth directed CMEs are currently forecast.

Waning effects of HSS from CH51/+ and the likely passage of a transient slow CME to start with wind speeds expected to decline slowly towards Background through Days 1 and 2 (5th, 6th). The next enhancement is expected to be the arrival of a high speed stream from CH53/- during Day 3 (7th), with effects continuing into Day 4 (8th). This coronal hole is markedly larger than on its previous rotation, as such, recurrence modelling and SWPM are thought to give poor guidance later in the period. MOSWOC Enlil suggests peak winds of 500-600 km/s arriving on Day 4. As we approach the December Solstice, geomagnetic response to fast winds arrivals are less likely to be significant, however there is still a chance of isolated G1/Minor Storm intervals.
Quiet to Unsettled geomagnetic activity expected through Days 1-2 (5th and 6th). Activity increasing to Unsettled to Active with a chance of G1/Minor storm intervals during Day 3 (7th), perhaps slowly easing Day 4 (8th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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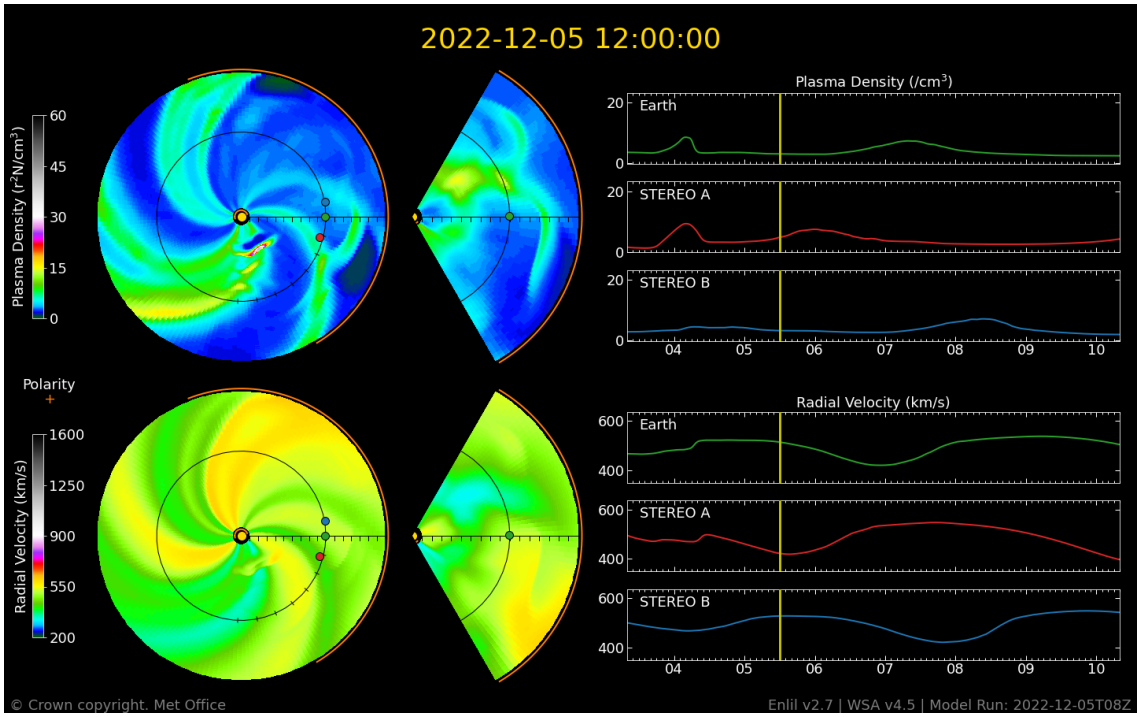
Figure 2: MOSWOC ENLIL – shows increasing solar winds during the 7th and 8th Dec, due to a fast wind from CH53/-



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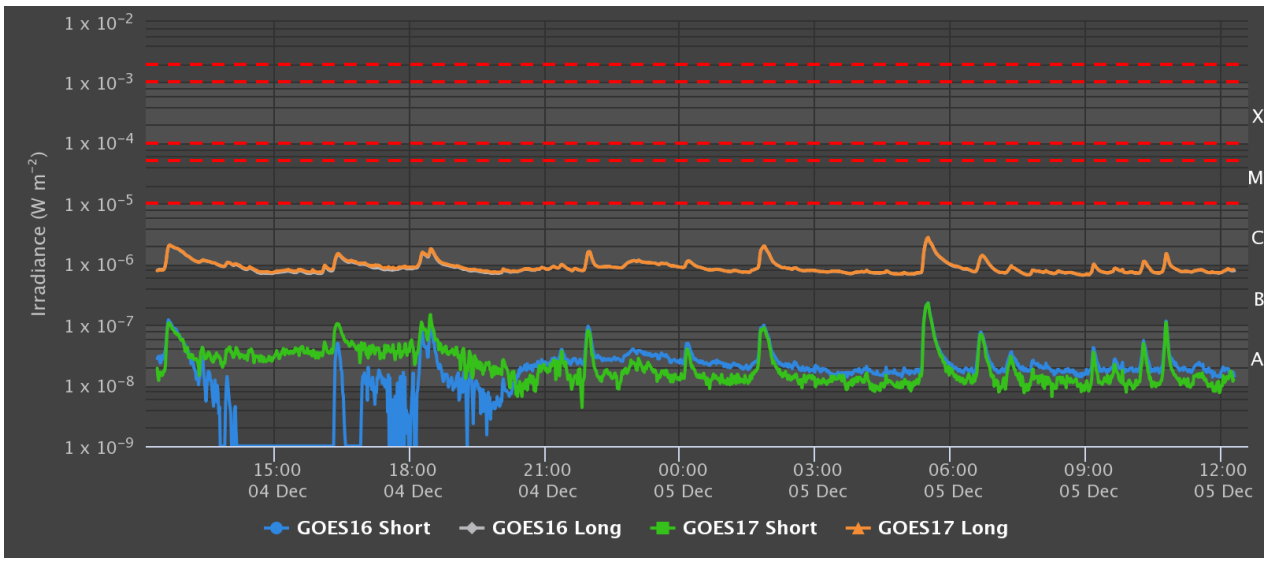
Radio Blackouts - X-Ray Flares:
Solar activity is expected to remain Low, but with the ongoing chance of increasing to Moderate with further isolated M-class flares.

There are currently five numbered and one unnumbered region on the visible disc. The largest sunspot remains AR3153 Fko/Beta in the southeast, which has recently shown some development in its intermediate spots. Despite the significant magnetic flux associated with this region, it remains relatively stable.

AR3158 Dai/Beta-Gamma in the north central disc has been the most developmental, proliferating a series of small spots and magnetic complexity. AR3155 Dsi/Beta in the northwest also continues to show development, with emergence and fading of interior spots and a gradual increase in size. AR3157 in the northern hemisphere continues to emerge from the eastern limb region and has been reclassified Dso/Beta, showing slight development, this was likely the source of the impulsive M1.3 flare on the limb seen at 03/1741 UTC. AR3156 in the northeast has shown little change. AR3154 in the southwest faded to plage. Of the previous unnumbered regions one has faded to leave the remaining one small and simple. Seismic far side imagery suggests further active regions likely rounding the eastern limb during the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	1	5	5	5

Figure 3: GOES X-Ray flares.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES-16, is currently at Background levels and is expected to remain at this level throughout the period. However, any significant flares from any of the multiple sunspots on the visible disc could give a very slight chance of observed protons at Earth increasing towards the S1/Minor Radiation Storm level, particularly later into the period as they rotate towards the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently fluctuating near High levels after some disturbance due to the arrival of the recent weak CME. Flux would be expected to persist at these levels, and perhaps rise back more persistently above High levels until the arrival of a HSS from CH53 on Day 3 (7th), at which point the observed flux is likely to fall to Background levels.

Associated fluence is expected to remain Active (above 1e8 integrated pfu) on Day 1 (5th), with a gradual decline to below active threshold as indicated by recurrence, which is probably giving better representation than REFM at present. However, there is a chance fluence may stay above the Active threshold into Day 2 (6th) before declining to below threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	40	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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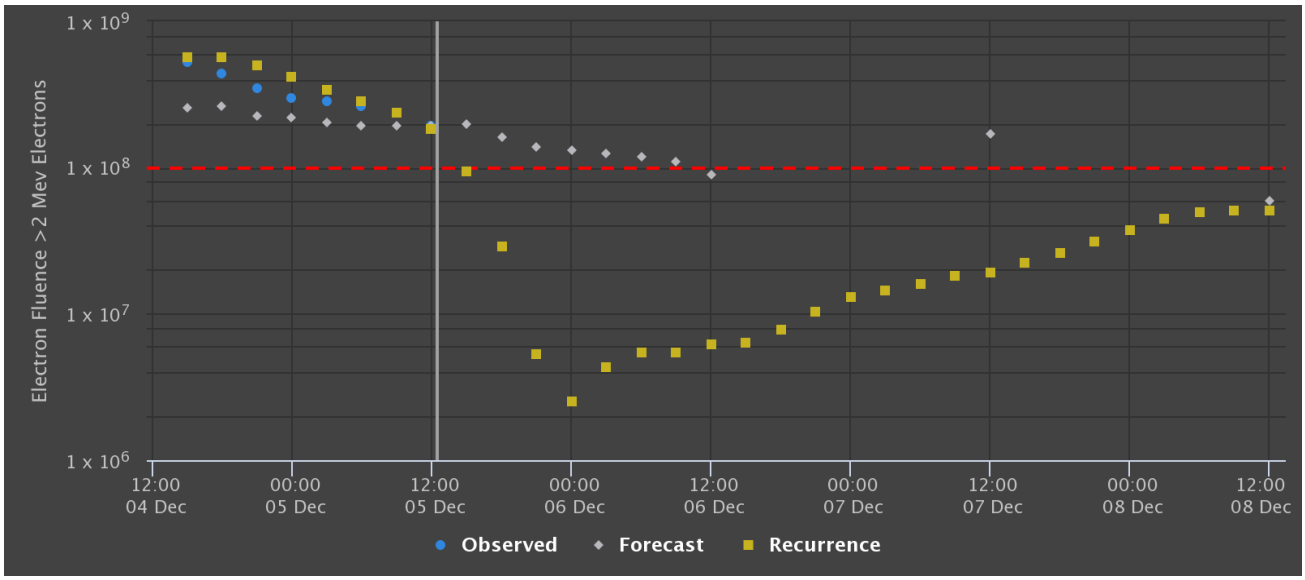
Figure 4: MOSWOC REFM model output, with observations and recurrence.



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